Game Changing Development

Autonomous Systems: Autonomous Cryogenic Loading Operations (ACLO)

Completed Technology Project (2011 - 2015)

Project Introduction

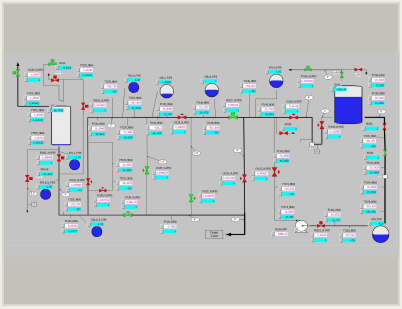
Multi-center team will develop and demonstrate new, state-of-the-art control architecture that enables next generation of health management techniques, intelligent devices and autonomous control technologies to perform autonomous control of a cryogenic propellant loading system.

The main objectives are to develop and integrate Integrated Systems Health Management (ISHM) tools and component technologies into a seamless health management architecture and to create an autonomous cryogenic loading capability. ACLO components will be developed for mission-relevant cryogenic platforms/environment (i.e., ground-based and micro-g in-space capability) and demonstrated against the KSC Cryogenic Test Facility's Simulated Propellant Loading System, a.k.a, the Cryogenic Testbed. The autonomous cryogenic loading capability and component technologies developed under the ACLO Project Element will be used to help mature concepts for variable levels of autonomy and will enable NASA to rapidly adapt to and support various launch concepts with multiple vehicle types in a multi-use launch pad or an in-space environment. The ACLO Project Element will continue to build on capabilities and concepts developed and/or demonstrated in FY13 under ACLO and previous ground autonomy and health management efforts: Systems Autonomy Demonstration Program: Knowledge-based Autonomous Test Engineer (KATE), which proved the feasibility of using high-fidelity physics models and simulations to enable integrated system health, status and control for autonomous tank loading operations Constellation pathfinder demonstrations and trade studies: Ares I-X Ground Diagnostic Prototype & Fault Detection, Isolation and Recovery Architecture Prototype, which developed a certifiable configuration and approach for integrated health management for ground and launch operations AFRL Future Responsive Access to Space Technologies Program: Rapid Propellant Loading Project, which developed concepts for distributed launch operations and cryogenic loading operations using KATE and the Hybrid Diagnostic Engine

Anticipated Benefits

Reduces the dependance on a large workforce to conduct system operations by automating and integrating the fault diagnosis, isolation and recovery functions with a supervisory control function. Increases availability of cryogenic systems to support operations. Enables reduced development, operations and maintenance costs.

Enables variable levels of autonomy and supports objectives to rapidly adapt to and supportoperations for multiple system and subsytem architectures in both ground and a microgravity environments.



KATE Display of Cryogenic Testbed

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

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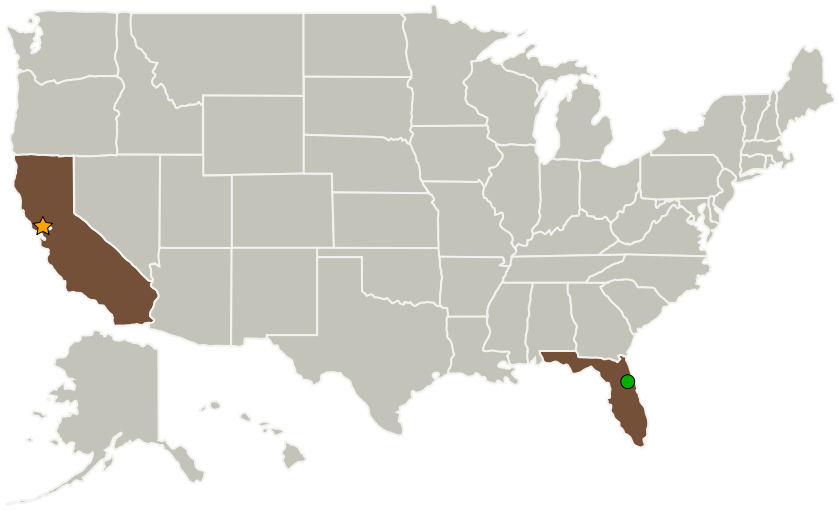
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Abacus Technology Corporation	Supporting Organization	Industry Small Disadvantaged Business (SDB)	
●Kennedy Space Center(KSC)	Supporting Organization	NASA Center	Kennedy Space Center, Florida
Stinger Ghaffarian Technologies(SGT)	Supporting Organization	Industry	

Primary U.S. Work Locations	
California	Florida

Project Management

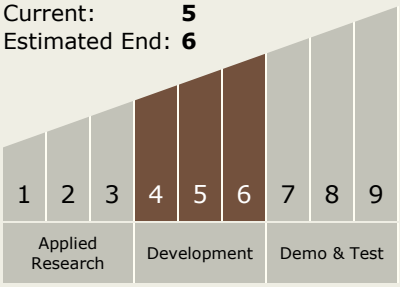
Program Director:
Mary J Werkheiser

Program Manager:
Gary F Meyering

Project Manager:
Barbara L Brown

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **6**



Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.1 Infrastructure Optimization
    - TX13.1.4 Propellant Production, Storage and Transfer

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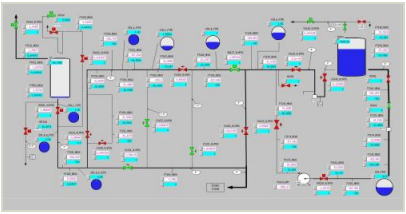
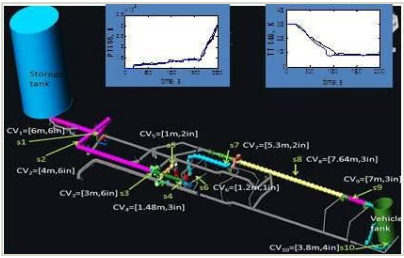
Images



KATE Display of Cryogenic Testbed

KATE Display of Cryogenic Testbed *(https://techport.nasa.gov/image/2970)*



Physics Model of Cryogenics Test Bed

Physics Model of Cryogenics Test Bed *(https://techport.nasa.gov/image/2969)*